Exam scope: All of the readings and lectures for weeks 1, 2 and 3.

Read and think about the review questions for each week.

Write out short answers for the questions....

TIP: Try to do it without your notes.
Share your knowledge: Participate on Piazza, call mom, tell your roommate...
When you actively process the information that is when the magic of learning happens.
INTRODUCTION TO COGNITIVE SCIENCE

- Boyle
- Week 1
- Quiz A
- No Assigned Reading
WHAT IS COGNITIVE SCIENCE ANYWAY?
What is Cognitive Science?

Interdisciplinary study of mind and its processes. **Main objective:** Understand how information is acquired, processed, transformed into behavioral output.

What are its main disciplines?

- Neuroscience
- Philosophy
- Computer science
- Linguistics

**The Mind**
How are these disciplines related?

**Neuroscience**
How does neural activity represent, store information and how does it translate to behavior?

**Philosophy**
 Defines key questions: What is reasoning, meaning?

**Computer science**
Create systems that simulate cognitive processes and output

**Linguistics**
How is meaning/information represented and conveyed?

**The Mind**
This is what some linguists study and argue about! Some main theories by:

**Pinker**, argues language is innate human ability

**Elman**, argues language use arises from experience, it is learned
BCI: “READING MINDS”

What is BCI? What does it mean to “read the mind”?

Brain Computer Interface.
Field of research, uses...

...sensors to record electrical activity, which computer decodes in order to control external device accordingly.
How does cognitive science differ from... computer science, neuroscience, philosophy, psychology, and linguistics?

Independently, each field could investigate questions unrelated to cognition.

Cognitive science, however, requires each field’s input in order to form a complete picture of cognition.
SLEEP

• Boyle
• Week 1
• Quiz A
• Assigned Readings:
  – Clocks Within Us
  – Why Can’t We Fall Asleep?
  – The Work We Do While We Sleep
  – The Walking Dead
  – Brain Facts Chapter 6: Sleep
  – Brain Facts Chapter 12: Degenerative Disorders

“Sleep is the golden chain that ties health and our bodies together.”

Thomas Dekker

Mary ET Boyle, Ph. D.
Department of Cognitive Science,
University of California, San Diego
WHAT IS SLEEP?
WHAT IS ITS RELATIONSHIP TO COGNITION?
HOW DOES IT RELATE TO YOUR HEALTH?

THE 3 BIG QUESTIONS FOR THIS LECTURE ARE:
What does sleep have to do with it anyway?

Grade point average by amount of sleep

<table>
<thead>
<tr>
<th>Hours of sleep per week</th>
<th>Under 5</th>
<th>5 to 6</th>
<th>7 or more</th>
</tr>
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<tbody>
<tr>
<td>Mean GPA</td>
<td>3.0</td>
<td>3.2</td>
<td>3.4</td>
</tr>
</tbody>
</table>
HOW DO WE FALL ASLEEP?

External Cues

- What is a zeitgeber? Examples?
- What is the role of melatonin and light in regulating circadian rhythms?
- What is so important about blue light?
- What factors are associated with our ability to go to sleep?
Internal Regulators of Sleep & Wakefulness

SUPRACHIASMATIC NUCLEUS (SCN)

What is it?
What is its function?
Where is it?

How does it perform this function?

Fat tissue
Liver
Digestive tract
Muscle
MORE REGULATORS...

- Adenosine (Basal forebrain and cortex, ↑ awake time ↑ production)
- Orexin (hypothesis)
- Melatonin (SCN - bundle of cells located in hypothalamus)
ME AND YOU AND CYANOBACTERIA:

How are we similar to cyanobacteria?
- Predict rather than respond!
- Anticipate metabolic demands by increasing or suppressing protein expression, hormone, and neurotransmitter release

Why does “When we go to bed affects how long you sleep, no matter how tired you are.”?

How is the functionality of insulin affected by time of day?
What happens to your body when you fall asleep?

### PHASES OF HEALTHY SLEEP:

<table>
<thead>
<tr>
<th>SWS</th>
<th>REM</th>
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<tbody>
<tr>
<td>(slow wave sleep)</td>
<td>(rapid eye movement)</td>
</tr>
<tr>
<td>• muscle relaxation</td>
<td>• atonia (muscle paralysis; exceptions for respiratory muscles-yay! And eye muscles)</td>
</tr>
<tr>
<td>• ↓HR, BP, body temperature</td>
<td></td>
</tr>
</tbody>
</table>

- Both duration of overall sleep and the duration of individual stages of sleep vary over the course of development.
EFFECTS OF SLEEP DEPRIVATION:

**Short term** sleep deprivation leads to:
- Cognitive and behavioral changes
- Decreased ability to concentrate
- Decreased short-term memory
- Paranoia and hallucinations

**Long term** sleep deprivation leads to:
- Cardiovascular stress (elevated heart rate and blood pressure)
- Disruption of the lymphatic system and thus build up of toxins
- Impaired executive functions
- Impaired emotional responses
- Impaired decision making

In children chronic sleep deprivation may lead to hyperactivity and impaired interpretation of social cues
**CHRONIC SLEEP DEPRIVATION DISORDERS**

**REM-sleep behavior disorder**
- Paralysis during REM sleep does not occur → dreams are acted out
- Increased risk for neurodegenerative diseases

**Sleep apnea**
- Breathing pauses for seconds to minutes during sleep → body briefly jolts to continue breathing
- Cognitive impairments
- Increased risk for diabetes, cardiovascular diseases
THE INFLUENCE OF SLEEP DISRUPTION ON DIABETES AND AD

- metabolic disruption
- weight gain, obesity
- impaired immunity
- cognitive malfunction
OTHER SLEEP STUFF TO MAKE SURE THAT YOU UNDERSTAND:

- Where and what is the master clock?
- What is the big deal about blue light?
- What is sleep inertia?
- What is the cognitive and physical performance of someone who has not slept in a 24-hour period?
LATERALIZATION OF FUNCTION

• Coulson
• Week 2
• Quiz B
• Assigned Readings
  – Seeing the Brain Speak
  – Images of the Brain Refute Theory of Language
The 2 main questions for this lecture are:

How is the brain organized?

How does language provide insight into the organization?
GOTTA KNOW THE BRAIN!

What are the different lobes of the brain?

Where is:
- M1
- A1
- V1
- S1
- Broca’s area
- Wernicke’s area
- SCN
- Hippocampus
- Corpus callosum
- Dentate gyrus
- CA1, CA2, CA3

What does each lobe do?
Q. Why would COGNITIVE SCIENTISTS care about genetics and epigenetics?
Genetic code determines a lot of who you are, but, not everything!
The epigenome “marks” the genome’s functions, which can be controlled.
EPIGENOME IS SENSITIVE TO THE ENVIRONMENT
MEMORY DEVELOPMENT DISEASE

COGNITIVE SCIENCE QUESTIONS
Since DNA discovery, geneticists have been exploring how differences in DNA impact human health.
1. Difficult to link genes to disease

2. Most traits & pathologies involve more than genes

Since DNA discovery, geneticists wonder how differences in DNA relate to human health.
Since DNA discovery, geneticists have been trying to figure out how differences in DNA correlate with human health.

1. Difficult to link genes to disease
2. Most traits and pathologies involve more than genes

The epigenome provides an additional level of control. Genes can be silent or active without changing DNA itself.

Modulate DNA activity by modulating epigenetic processes.
There is debate as to the heritability of epigenetic changes.
A woman who smokes while pregnant induces epigenetic changes in three generations at once: In herself, her unborn daughter, and her daughter’s reproductive cells.
Week 3.

Dr. Eran Mukamel - Tales of Adversity
Tales of Adversity reading.

It is well established that a pregnant woman’s habits affect the health of her unborn child, but the extent of the impact is less well known. Recent studies of tragic historical events, namely the Dutch Honderwinter and the Great Chinese Famine, have begun to highlight the trans-generational relationship between food and genes.

Many children conceived during the Honderwinter were small and underweight. What’s more, certain health problems have persisted long into their adult lives. Compared to their siblings conceived before or after the famine, the Honderwinter children are at increased risk for obesity, for example. A propensity for obesity was also found in children of the 1968–1970 Biafra famine in a recent study in Nigeria.
Theory of Inheritance of Acquired Characteristics  
Theory of Survival of the Fittest
- Difficult to link genes to disease
- Most traits involve more than genes
- Strongly influenced by the environment
- How do geneticists discover human health DNA differences?
- Geneticists since DNA discovery
- Diets, toxins, exposure, exercise, sleep,
  drugs, etc.
EPIGENETIC PROCESS

1. Difficult to link genes to disease

2. Most traits and pathologies involve more than genes

3. Can impact any stage of life

Example:

Muscle cell

Epigenetic markers govern cell differentiation.
INTRO TO GENETICS WITH DATA SCIENCE

• Ellis
• Week 2
• Quiz B
• Assigned Reading:
  - Predicting your future using your genes.
THE 2 MAIN QUESTIONS FOR THIS LECTURE ARE:

GENETICS – A WHIRLWIND TOUR

HOW CAN WE USE DATA SCIENCE TOOLS TO INFORM AND VALIDATE SCIENCE?
BRAIN CELLS AND EPIGENETICS

• Mukamel
• Week 3
• Quiz C
• Assigned Readings:
  – Epigenetics Explained-Scientific American
  – Mice Inherit Specific Memories, Because of Epigenetics
  – Tales of Adversity
THE 3 BIG QUESTIONS FOR THIS LECTURE ARE:

WHAT IS EPIGENETICS?

HOW DOES EPIGENETICS INFORM THE NATURE/NURTURE DEBATE?

WHAT TOOLS/TECHNIQUES ARE USED TO UNDERSTAND COMPLEX DATA?
Categories of Differences:

- Location (area, layer)
- Connection (inputs / outputs)
- Electrical / chemical responses
  - Excitatory or inhibitory?
- Morphology
ADULT NEUROGENESIS

• Rangel
• Week 3
• Quiz C
• Assigned Reading:
  – Saving New Brain Cells
WHAT IS NEUROGENESIS?

WHERE AND WHEN DOES NEUROGENESIS OCCUR?

HOW DOES NEUROGENESIS IMPACT COGNITION?

THE 3 BIG QUESTIONS FOR THIS LECTURE ARE:
There are two main neurogenic regions

The subgranular zone of the dentate gyrus:

www.BrainConnection.com
Scientific Learning Corp., 1999

The subventricular zone of the lateral ventricle:

Huart, Rembatus, and Hummel, 2013
The dentate gyrus is important for helping us discriminate between similar experiences.

Neurons in the dentate can detect differences between experiences by demonstrating highly selective and specialized activity.

Adult-born neurons may facilitate the allocation of selective and dedicated activity for new experiences in the dentate gyrus.

The dentate gyrus (in the hippocampus) is important for being able to discriminate between similar experiences.

Rats require a dentate gyrus in order to discriminate between a new and old spatial location.

Bakker et al., 2008

The dentate gyrus (in the hippocampus) is important for being able to discriminate between similar experiences.

Humans show stronger activation of dentate gyrus when presented with an object subtly different from another object seen previously.

Gilbert et al., 2001
Aimone et al., 2011
Quantifying neuron proliferation (rate of division) and survival

Measuring Proliferation

Control: BrdU, DCX, Ki67
- No manipulation
- How many cells are dividing or are immature at this time?

Experimental: BrdU, DCX, Ki67
- Add manipulation
- How many cells are dividing or are immature at this time?

Measuring Survival

Control: BrdU
- No manipulation
- 1 week
- No manipulation
- How many adult-born cells survived 4 weeks later?

Experimental: BrdU
- No manipulation
- 1 week
- Add manipulation
- How many adult-born cells survived 4 weeks later?

5-bromo-2’-deoxyuridine (BrdU): a thymidine analog that is incorporated into the DNA of dividing cells during their S-phase

Mak et al., 2013
Proliferation (rate of division):
- Stress  
  Schoenfeld and Gould, 2012  
  decreases
- Physical Exercise  
  van Praag et al., 1999  
  increases
- Antidepressants  
  Boldrini et al., 2009  
  increases
- Aging  
  Kuhn et al., 1996  
  decreases
- Seizures  
  Jessberger and Parent, 2015  
  increases

Many things can influence adult neurogenesis survival is highly regulated

Survival:
- Learning  
  Dupret et al., 2007  
  increases
- Alcohol  
  Crews and Nixon, 2004  
  decreases
- Dietary Restriction  
  Kitamura et al., 2006  
  increases
- Enriching Environments  
  Tashiro et al., 2007  
  increases

Adult neurogenesis can be regulated at different stages of neuron development.

Increased proliferation does not necessarily mean that there are more that survive.
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>6</td>
<td>Dr. Deak (5/2) How do we become socially skilled?</td>
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<td>TBA</td>
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<td>7</td>
<td>Dr. Kirsh (5/7) TBA</td>
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<td></td>
<td>Dr. Bergen (5/9) Your Brain on Swearing</td>
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<td>Quiz E in section</td>
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<td><strong>REVISED</strong> 10:46 pm, Apr 24, 2019</td>
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<td>*How Babies Think (<em>EC Prereading quiz: opens on TritonEd Wednesday, May 1 @ 4pm – Tuesday, May 2 @ 10am.)</em></td>
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<td><em>What Profanity Teaches Us About Ourselves</em></td>
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<td>7</td>
<td>Dr. Cottrell (5/14) Introduction to Neural Networks</td>
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<td></td>
<td>Dr. Boyle (5/16) Midterm-2 Review</td>
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<td>Quiz F in section</td>
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<td>Next week: Midterm 2 – May 21st in class- scantron provided 😊</td>
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<tr>
<td>7</td>
<td>*For Dummies — The Introduction to Neural Networks we all need! (<em>EC Prereading quiz: opens on TritonEd Monday, May 13 @ 4pm – Tuesday, May 14 @ 10:00am)</em></td>
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<tr>
<td>7</td>
<td>#A Six Unit Network is All You Need to Discover Happiness (<em>Optional reading)</em></td>
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Note: EC quizzes are before lecture

*How Babies Think
(*EC Prereading quiz: opens on TritonEd Wednesday, May 1 @ 4pm – Tuesday, May 2 @ 10am.

Dr. Deak (5/2)
How do we become socially skilled?

* The purpose is to prepare you for lecture!! 😊
REFRESH YOUR BROWSER!
(OFTEN!)
COMMENTS ON —

1. BEING PROFESSIONAL

2. KINDNESS
3. BE GRATEFUL

YOU WILL BE HAPPIER & LEARN MORE, TOO 😊

YOUR IA's have worked VERY HARD TO HELP YOU. ❤️